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SURVEYS AND MAPS.*

The part of Col. Sir Duncan Johnston's paper here summarized deals with the regular survey and mapping of new areas. He divides maps into three classes: (1) Geographical Maps, those on very small scales, such as most atlas sheets; (2) Topographical Maps, which for the purpose of his address, he considers as maps between the scales of 4 miles to an inch and 0.3 mile to an inch; and (3) Cadastral Maps, on large scales mainly for property purposes. His remarks are limited to topographical surveys and maps.

In most of the older countries, topographical surveys have originally been made to meet military needs. Their use, however, is not limited to military purposes, and they have proved to be of great value for civil requirements. They are constantly used in connection with civil administration and with public and private business of all kinds. Directly or indirectly all the many maps, prepared by commercial map houses in Great Britain for civil use, are based upon the topographical maps of the Ordnance Survey.

The first preliminary to any survey should be a triangulation, and the best economy, in the long run, is to carry out, with the greatest accuracy possible, the primary triangulation on which the survey is to be based. Such a triangulation will remain good for a very long period. Some doubts have been expressed as to whether the triangulation begun by the Ordnance Survey in 1791 is accurate enough to combine with more recent work for the purpose of investigating the figure of the earth; but no one has questioned the adequacy of even the earliest part of the triangulation for map-making purposes.

He does not advocate a primary triangulation until arrangements are made for basing a survey on it. In South Africa, for example, a very accurate triangulation has been carried out, but, so far, no surveys of great extent have been based on it. Triangulation is now much quicker and less expensive than formerly. Invar tapes and wires have expedited and simplified the measurement of base lines, and large and cumbrous theodolites have been supplanted by small and handy instruments. Unless many trees, buildings or a hazy

* This article is a condensation of the address delivered by Col. Sir Duncan Johnston, K.C.M.G., C.B., R.E., President of Section E. Geography, of the British Association, at its opening meeting in Winnipeg, Can., in August last. The paper has been printed in full, in *Nature*, No. 2,080, and that part of it relating to Surveys and Maps, in the *Geographical Journal* for October, 1909.

atmosphere make observations difficult, a good primary triangulation should not now be very expensive.

It is usual to base on the primary triangulation a minor triangulation of several orders, the object being to have an accurate framework of trigonometrical points on which to base the survey. If it is important to keep the expense low, the trigonometrical points may be rather far apart, intermediate points being fixed by plane table; but it should be remembered that it is the truest economy to make the best triangulation which funds admit of. In forests or in wooded or rather flat country, where triangulation would be very expensive, lines of traverse made with every possible accuracy, and starting and closing on trigonometrical points, may be used instead of minor triangulation.

Provided the detailed survey is based on triangulation, it may be made by any recognized method. Plane tabling is very generally used, and is probably as cheap and convenient as any method. The vertical heights of the trigonometrical points will have been fixed by vertical angles with reference to some datum. The height of intermediate points may be fixed by clinometer lines, and even by aneroid, and from these heights the contour lines may be sketched in. Altitudes may be more accurately fixed by spirit levelling, but this is expensive. In exceptional cases, photographic surveying may be employed and photographic methods sometimes permit work to be done that is not otherwise feasible. The photographic method suggested by Captain F. V. Thompson, R.E., is an advance on previous methods. A good deal of photographic surveying has been done in Canada where the conditions, presumably, have been found suitable for this method. It has been little used elsewhere.

The author treats the scale of topographic maps at length and enumerates the scales used by the principal government surveys. The cost increases with the scale and is therefore one of the chief determining considerations. The physical and artificial character of the country, the amount of detail it may be decided to show on the map, the method adopted for representing hills and other detail, and the method of reproduction to be used, all affect the question. The scale should be such that all detail may be shown without overcrowding. He suggests that for countries using British measures, in which, owing to dense population, the detail is close, the 1-inch scale is a very good one; and for more open parts, the $\frac{1}{2}$ -inch scale may be adopted with advantage. For countries using metrical measures he advocates the scales of 1:62,500 and 1:125,000 respectively. These scales do not differ largely from those adopted by most of the principal countries. With regard to the scale of field survey work he says:

It is usual to make the field survey for small scale maps on a larger scale than that on which the map is to be published, with the view of securing greater accuracy of detail; but this should not be overdone. If the field survey is on too large a scale it entails needless expense; also when the surveyor is working on too large a scale he is apt not to realize the effect of reduction on his survey, and is likely to survey so much detail as to overcrowd the map, thus increasing the cost of the work and injuring the map.

Sir Duncan believes that the best results are obtained when the field survey is made on double the scale of the finished map; that if reproduction is to be made by engraving, the fair drawing should be on the same scale as the finished map; that if, on the other hand, reproduction is to be by photography, the fair drawing should be on the same scale as the survey, *i. e.*, double that of the finished map. The reduction should conduce to accuracy of detail, and, if reproduced by photography, to fineness of detail, while it is not so great that the surveyor and draughtsman should be unable to realize the effect of reduction.

The author discusses the amount of detail to be shown on the different scales and the conventional signs used to represent it. He thinks the less small detail shown the better, for it adds to the cost and often over crowds the map. The German 1:100,000 scale shows much small detail, and although the maps are beautifully engraved on copper, the detail is rather crowded on some sheets. The question on which opinion differs most is the method of representing ground forms. Methods which answer well on steep ground are less satisfactory on gentle slopes and *vice versa*. He shows the different methods employed by the various countries in indicating ground forms by contours, hill shading in stipple, vertical hachures, horizontal hachures, the layer system, or by a combination of some of these. Contours give almost the effect of hill-shading where the slopes are steep. Some of these contoured maps give a very good representation of the ground, the best being those in which the contours are in colour. In mountain regions, stipple shading gives a good pictorial representation of the ground, but it fails in flatter country.

Vertical hachures, when well executed, give an artistic and graphic representation of the hills. In the Swiss and British maps the pictorial effect is enhanced by assuming a light from the left hand top corner. He thinks hachures are better when printed in colour, for black hachures, on steep ground, are apt to obscure detail or names.

The layer system is used in Great Britain by the map house of J. Bartholomew & Co., has recently been adopted by the Ordnance Survey for its $\frac{1}{2}$ -inch maps and is used in the $\frac{1}{2}$ -inch maps of Canada. It consists in indicating, by various shades of colour, the area lying between certain contours; thus one shade is given to all ground below the 50-feet contour, another shade to the ground between the 50-feet and 100-feet contour, and so on. This system gives a general indication of ground form and enables the contour lines to be followed more easily. The shades of colour enable the

eye to pick out all land lying at about the same level. This method enables those who are not versed in reading contours and hachures to get some idea of the nature of the ground forms. In the author's opinion:

Contours reasonably close together should form the principal feature of any method of representing ground forms. Contours by themselves give a very fair representation of the ground. Vertical hachures, if printed so as not to obscure the detail and names, or stipple shading, when there is not too much colour on the maps, increase the pictorial effect and are useful additions to contours; ground forms should preferably be in colour, and where hachures or stipple are used, as well as contours, both should be in the same colour.

With regard to the vertical interval of contours, he thinks that if the contours are printed in colour the vertical interval may be such that, on steep ground, the contours will be reasonably close together, but if the contours are in black, they cannot, with advantage be so close. He thinks it preferable for the contour interval to be uniform throughout a country, but this view is not universally held.

Sir Duncan also considers, at some length, the reproduction of maps, and is inclined to think that if considerations of time and cost do not admit of reproduction by engraving on copper, the map should be reproduced by some photographic method and printed in not more than five colours.

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION.

If there was some early scepticism as to taking the British Association to the remote capital of Manitoba for the meeting of 1909, no trace of hesitation remained when the officers and members began to gather on the prairie in the closing days of August. Several hundred from Great Britain, a number from the Continent, a hundred or more from the United States and the remainder from Canada, made up nearly or quite 1,400 members. With true Western spirit there was satisfaction that the enrollment of Montreal in 1884, and that of Toronto in 1897, were exceeded by the chief city of western Canada.

The very complete arrangements were possible through the interest of citizens of Winnipeg, and by reason of liberal grants from the Dominion and also from the governments of each of the western provinces. The Honorary Local Secretaries were Mr. C. N. Bell, Hon. W. Sanford Evans, Mayor of Winnipeg, Professor M. A. Parker and Professor Swale Vincent. The local appointments left little to be desired, and the secretaries in charge exhibited, in this regard, such efficiency as might well be emulated by other local committees. A large and bare drill hall was made attractive by decorations, and the completeness of its offices, and of its facilities for correspondence and for conferences and social greetings, added much to the satisfaction of every guest. The rooms for sectional meetings were in every case ample in size, light, seating, and in the equipment of lanterns and other conveniences for the presentation of papers. Very full space was